Fermilab

$\bar{P}$ NOTE #353

BOOSTER BEAM TARGET AND DUMP FOR TEVATRON I

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This note describes our present thoughts with reference to the target and dump region of the Booster Target Station for Tevatron I.

Enclosure and Shielding

Shielding calculations were performed by P. Yurista (Accelerator) and were used as input for the TITLE I design. These calculations have been recently redone for the actual geometry of TITLE I. Although civil engineering changes are expected to modify the details of that design, we expect the steel shielding to remain to our specifications. Shielding calculations are available as a separate write up.

The target shielding is to surround the target and dump by 3′ of steel to the top and sides and 5′ to the bottom. The steel is to be surrounded by a reinforced concrete vault of thickness between 1′ and 2′. We expect to install the steel shielding and permanently enclose it in place. Servicing and removal of radioactive components is to take place to the side and/or downstream tunnel space. In no case handling or repair or radioactive components is to take place within this area. Radioactive components are to be removed and immediately enclosed in shielding containers for removal or storage.

The target vault is to be surrounded by protected soil and drainage into separate sump for radiation monitoring. The amount of protected soil will be of the order of 3′, although detail calculations have not been completed.

Radiation above the target vault, on top of the berm, is design to be of the order of 1.0 m Rem/hour such that under normal or accident conditions it can be treated as a minimal occupancy area. (Appendix 1)

Steel Shielding and Dump Core

i) Shielding

As per TITLE I drawings the steel shielding is to surround the target and dump. The target itself should be located between 2′ to 4′ into the shielding from its upstream face. The total length of the shielding along the beam direction should be of the order of 23′. For comparison the present Booster dump is composed of 8" thick vertical steel plates $\backsim$ 6′x6′ with a total length of 12′. The extra length permits to include within the shielding the first stage of collimation of the scattered beam to be transmitted to the Debuncher. (See Figure 1 for reference only)

An opening of the order of 2′x2′ on the concrete vault downstream face is to be used for removal of the dump core and collimator. An opening to the side and opposite to the target location of dimensions 12" tall and 6" wide will be required to service and replace the target itself.

ii) Ventilation

No detail study has been done of air borne radioactivity. No ventilation of the area, will require a delay of the order of 20 minutes before a personnel access is made after beam operation. As this area may be directly connected to the Booster tunnel this may not be convenient. Alternatives such as sealing the target vault or continuous ventilation with $\sim$20 minutes circulation before release to the atmosphere need to be studied in detail.

iii) Dump Core

For normal operation (8 GeV, 3×10^{12} protons, 2 sec repetition rate) a power of the order of 1900 W will be deposited in the dump. The design will be performed for the average repetition rate of the booster (1 second) and the figure of 3800 watts will be used. Under accident conditions the Booster could deliver the same intensity at 15 Hz for 13 pulses, resulting on $\sim$63 kJ over 0.87 seconds or 72.7 kW of instantenous power.

To prevent possible damage the dump core should probably contain an initial length of graphite before the beam impinges on the steel. A core similar in design to the $\bar{p}$ target station, but shorter, could be used.

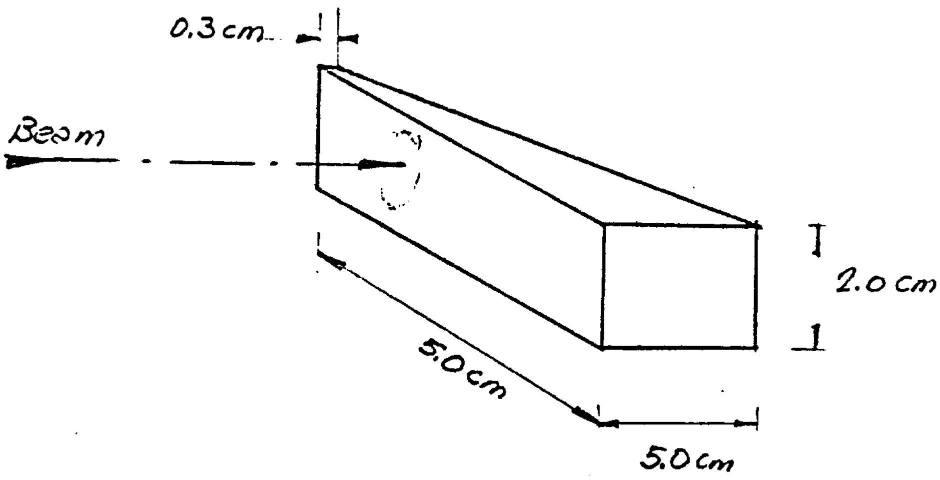
The vault surface in contact to the ground seems sufficient to dissipate the power levels under consideration.

Target

Calculations are presently under way to optimize target length, material and geometry. Attenuation factors of the order of 10^{-2} to 10^{-5} are required to vary the scattered beam intensity for 10^{10} p.p.p. to 10^{7} p.p.p.

A geometry that prevents direct transmission of the intense proton beam and intensity variation has been designed by D. Johnson. The Booster beam is to be targeted down, with an angle variable between 10 mrad and 50 mrad, to the horizontal. The scattered beam is horizontal and can be collimated within the steel shielding, to the order of 1 cm x 1 cm at the downstream end of the shield. The beam spot at the target and/or the collimator aperture can be varied to change the emittance of the scattered beam. (Use of the beam spot simplifies the design of the target shield as fixed collimators could be used).

For 1 cm long targets of carbon and copper attenuation factors of 3.5×10^{-4} to 1.8×10^{-8} 1) can be obtained. To have flexibility we expect to use targets of Be, carbon and copper (or equivalent) of approximate dimensions:



that can be moved across the beam (remotely) to vary the target length. Different materials could be stacked on top of each other for remote or manual operation. These small targets can be withdrawn to the side into a small shielded box for disposal (hand carried).

Notes

1) We have use cross sections from Blieden et al PRD (75) 11, 14. Detail calculations are underway.

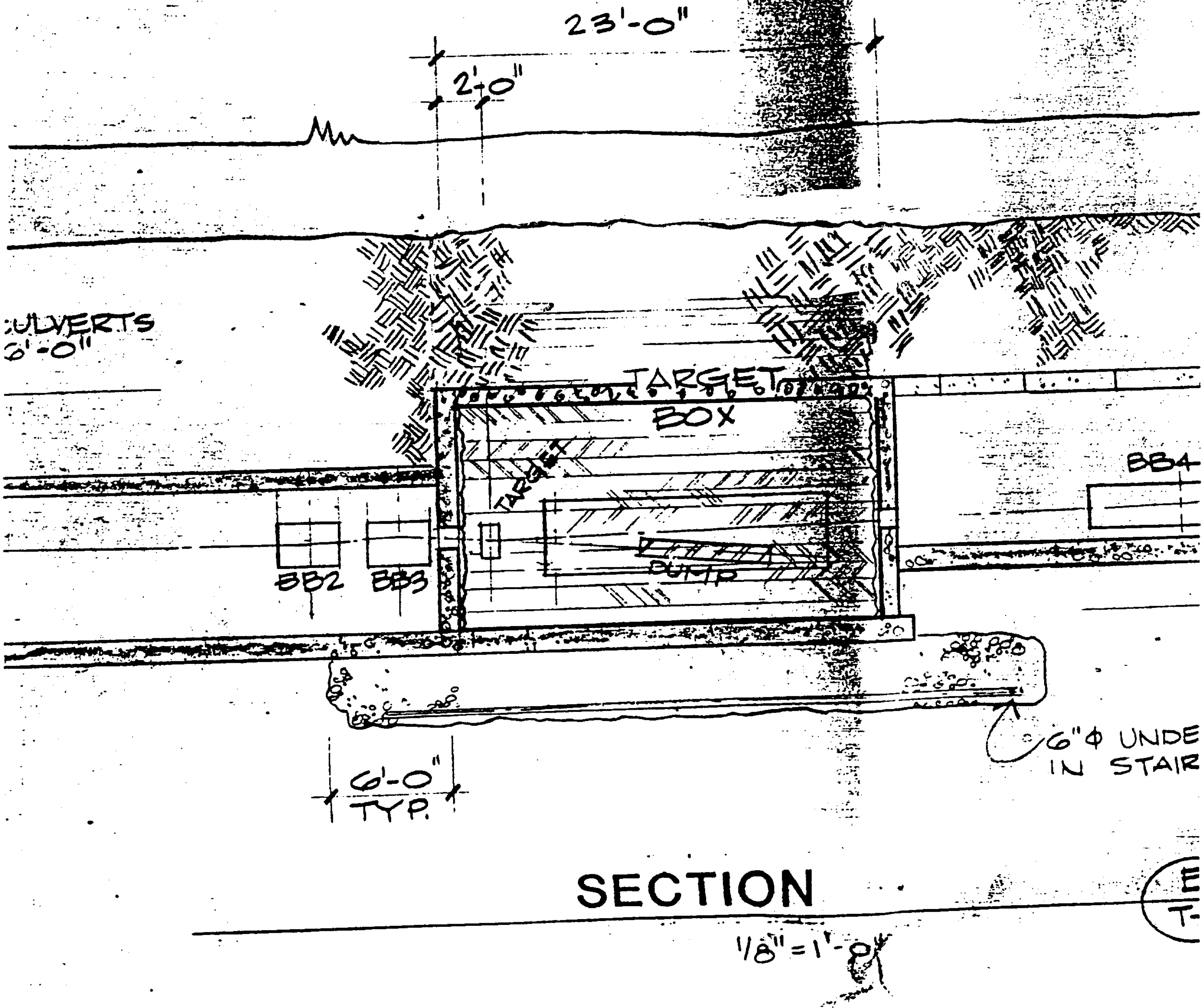


FIGURE 1

Schematic only.

12/9/83

TO: Carlos Hojvat

FROM: Pedro Yurista

Subject: Above ground dose rate calculations for 8 Gev target station.

A Maxim monte carlo calculation was performed to verify sufficient shielding over the 8 Gev target station for Acumulator/Debuncher tune up from the Booster ring. Earlier calculations were used for designing the configuration in the Title I drawing 6-2-1-S-23.

Cylindrical approximations were used for the interface of material in the vertical direction from the beam line to ground elevation.

At ground elevation of 747'-6" with beam elevation 727'-10" the MAXIM run RMYOCHS estimates $2E\text{-}14 \frac{\text{Stars}}{p \cdot cm^3}$. For $\frac{3E12\, p}{2\,\text{sec}}$ we have;

$$\left(2E\text{-}14 \frac{\text{Stars}}{p \cdot cm^3}\right)\left(\frac{3E12\, p}{2\,\text{sec}}\right)\left(\frac{3600\,\text{sec}}{hr}\right)\left(\frac{.01\,\text{mRem}}{\text{Stars}/cm^3}\right) = 1.1 \frac{\text{mRem}}{hr.}$$

This meets the Radiation Requirement for normal and/or acident conditions for a minimal occupancy area such as a berm.

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H. Casebolt
D. Johnson